

# STANDARDS

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# STANDARDS

## General Design Standards

### International Code Council, ICC Codes and Standards

<http://www.iccsafe.org/>

### National Fire Protection Association, NFPA

<http://www.nfpa.org>

### Underwriters Laboratories, UL

<http://www.ul.com/>

### Factory Mutual, FM

[http://www.fmglobal.com/scripts/store/item\\_details.asp?catid=13&prodID=5](http://www.fmglobal.com/scripts/store/item_details.asp?catid=13&prodID=5)

## Document Standards

### Specifications

Specifications are the portion of the contract documents that define administrative and quality requirements for products, materials, and workmanship. Specifications published by the Denver Service Center use [Construction Specifications Institute](#) (CSI) formats common throughout the construction industry. These formats are covered in detail in the "CSI Manual of Practice," available for reference in DSC Contracting Services Division Administration or for purchase through CSI. Guide specifications in these formats are available through [Masterspec®](#).

- [Divisions 1](#) (DSC Guide Specs)
- [Guide Template](#) (DSC Guide Specs, included in zip file with Divisions 1)
- [Help Document](#) (For using DSC specs.dot template, included in zip file with Division 1)
- [Specs.dot](#) (DSC Guide template in MSWord, included in zip file with Division 1)
- [Hints for Preparing Specifications for DSC Construction Projects](#)
- [Guideline for Writing Outline Specifications](#)

### Specification Formats

#### Review Specifications

Paper copies as specified below

#### Final Construction Documents

- Use CSI outline format
- Index indicating spec section number, title, and the number of sheets per section
- Times New Roman 11 point font
- 8-1/2" x 11" portrait
- Consistent Headers and Footers (all upper case)
  - Spec section number and page number on the right upper corner of the footer (flush right)
  - Spec title in all caps below page number (flush right)
  - Park and PMIS and/or Package number on the upper left of footer (flush left)
- Electronic files.
  - Electronic files shall be provided in Microsoft Word (.doc) and Indexed PDF file formats.

- A/E shall ensure that all sections are included in each format type.
- Documents shall have all DSC approvals prior to making the PDF copies. (including TIC)
- Each section shall be an individual file
- Use CSI section number as the file name.
- CD ROM's shall be clearly labeled with the following project information:
  - Park four-letter alpha code
  - PMIS/Package Number
  - Drawing Number
  - Project Title
  - Location within park
  - Date submitted (i.e. December 2004)
  - Name of A/E prime contractor
- Specification File Format and Media Requirements for Final Construction Documents

File Format	Media
PDF*	CD ROM
MS Word	Paper

PDF\* - Individual sections shall be linked to the table of contents and have the appearance of 1 file. Specification files shall not exceed 10MB and may need to be divided into separate volumes. Break volumes at logical breaking points i.e. between divisions. Cover sheet shall note volume and divisions included. Use Standard NPS Cover.

- Contract Price Schedule
  - MS Word or Excel format

## DSC Guide for Specifiers

- Guide for Specifiers, January 1995, with Addenda (Need new link)

## Cost Estimating

Use Construction Specifications Institute's (CSI) Masterformat™ numbering system or UNIFORMAT II (ASTM E1557 for classification of building elements and for classification of building-related site work) for all estimates and quantity takeoffs. All estimates must provide information in a form which allows reviewers to evaluate the costs of individual items based on quantities and unit costs. All estimates are net cost only and should reflect the probable cost that contractors will bid. All overhead, profit, AE design fees and any contingency shall be computed separately and added to the total of net contractor costs. Include all costs associated with the constructability analysis.

## DSC Drawing Formats

### Review Drawings

- Half size paper prints, 11" x 17"
- Electronic files shall be provided in AutoCAD (.dwg) format.

### Final Construction Documents

- Full-size prints, 22" x 34", on 20 pound engineering white bond paper, 300 dots per inch resolution
- Drawing cover sheet shall have construction contract solicitation number affixed.
- Electronic files, (format as specified)

- Electronic files shall be provided in AutoCAD (.dwg), PDF and TIFF\* file formats.
  - A/E shall ensure that all drawings are included in each format type.
  - Documents shall have all DSC approvals prior to making the PDF and TIFF\* copies. (including TIC)
  - Each drawing sheet shall be an individual file
  - Each PDF and TIFF\* file shall carry the NPS Sheet numbering file name 001, 002, 003, etc.
  - PDF and TIFF\* files shall be 300 ppi resolution files
  - The A/E shall ensure the AutoCAD (.dwg), the TIFF\* and the PDF files all print as identical full size drawings.
  - CD ROM's shall be clearly labeled with the following project information:
    - Park four-letter alpha code
    - PMIS/Package Number
    - Drawing Number
    - Project Title
    - Location within park
    - Date submitted (i.e. December 2004)
    - Name of A/E prime contractor
  - To create PDF's, scan full-size (ANSI D) drawings. This will reproduce the signature and stamp from the original set.
- Drawing File Format and Media Requirements for Final Construction Documents

File Format	Media
TIFF*	CD ROM
PDF (unzipped files)	CD ROM
PDF** (zipped files)	CD ROM
AutoCAD (.dwg)	CD ROM
Half-size	Paper
Full size (ANSI D)	Paper (Bond or 100% Cotton Vellum)

TIFF\* - Line drawings done in AutoCAD shall be fax CCITT group 4 compression; drawings that have photographs inserted shall be uncompressed greyscale TIF.

PDF\*\* - Sheets shall be zipped into files not exceeding 10MB. Name zipped files with included sheets (Sheets1thru20.zip)

## DSC CAD Resources

- [NPS/DSC CAD Drafting Standards](#)
- [Drafting Standards Checklist](#)
- [DSC Cadd User's Guide](#)
- [Reference Manual 10A](#)

- [NPS AutoCAD Tools](#)
- [Drawing Templates](#)
- [Sheet Borders](#)
- [Director's Order 10B Drawing and Map Numbers](#) (under development)

## Miscellaneous DSC Document Formats

### **Project Program**

- 8-1/2" x 11" portrait, with 11" x 17" fan-fold 1/2 size drawings, MS Word/Excel, AutoCad, and or hand-drawn document, TIFF or JPEG for photos

### **Value Analysis Report**

- 8-1/2" x 11" portrait, with 11" x 17" fan-fold 1/2 size drawings, MS Word/Excel, AutoCad, and or hand-drawn document

### **Basis of Design Report**

- 8-1/2" x 11" portrait, with 11" x 17" fan-fold 1/2 size drawings, MS Word/Excel, AutoCad, and or hand-drawn document, TIFF for graphics, JPEG for photos, spiral-bound with cover-stock cover

### **Historic Structure Report (HSR)**

- [Historic Structure Report \(HSR\)](#)

### **Cultural Landscape Report (CLR)**

- Cultural Landscape Report

### **Construction Cost Estimating Formats**

- 8-1/2" x 11" portrait, MS Excel

### **Product File**

- 8-1/2" x 11" portrait, with 11" x 17" fan-fold drawings, MS Word/Excel, spiral-bound with cover-stock cover.

### **Design Calculations**

- 8-1/2" x 11" portrait, MS Word/ Excel spiral-bound with cover-stock cover.

### **Other Miscellaneous Reports and Documents**

- 8-1/2" x 11" portrait, MS Word/ Excel spiral-bound with cover-stock cover.

## Design Standards

### Civil / Environmental Engineering Design Standards

#### **Site Design**

- Applicable AASHTO Design Guidelines
- AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing - Parts I and II
- Asphalt Institute standards
- Portland Cement Association standards
- Individual State Regulatory Agency regulations governing storm water management

#### **Water / Wastewater**

- Individual State Regulatory Agency regulations for water and wastewater
- Director's Order #83 - Public Health
- EPA Federal regulations
- AWWA standards
- ASTM standards
- ANSI standards
- NSF International standards

- NACE standards
- Federal Water Pollution Control Act and amendments
- Safe Drinking Water Act and amendments
- Surface Water Treatment Rule
- 10-state standards for wastewater projects
- Underwriters Laboratories, Inc., standards

#### **Hazmat**

- Resource Conservation and Recovery Act
- Comprehensive Environmental Response, Compensation and Liability Act
- Hazard Communication Ruling (part of OSHA, 29 CFR 1910.1200)
- Hazardous Waste Operations and Emergency Response
- EPA hazmat regulations
  - Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants
  - Asbestos Hazard Emergency Response Act
  - 40 CFR Protection of Environment
- Individual State regulations
- ASTM (Phase I and II Environmental Site Assessments)
- NFPA
- NACE
- American Petroleum Institute
- UL

## **Landscape Architecture Design Standards**

#### **Codes and Regulations**

- National, State, Local, and Park regulations and policies affecting project
- Park General Management Plan, EIS, EA, etc.
- Park Design Guidelines
- [Special Regulations for Areas of the National Park System](#)
- Americans with Disabilities Act (ADA) (See US Access Board for reference materials for ADA compliance)
- [Uniform Federal Accessibility Standards \(UFAS\), 1984](#)
- [Guiding Principles of Sustainable Design](#)
- [Greening Federal Facilities](#), An Energy, Environmental, and Economic Resource Guide for Federal Facility Managers and Designers
- [Director's Order 42, Accessibility for Park Visitors](#)
- [Director's Order 2, Park Planning, Chapter 2 of Management Policies, Park System Planning, and Planner's Sourcebook](#)
- [Director's Order 12, Environmental Impact Analysis](#)
- [Director's Order 90, Value Analysis](#)
- [Transportation](#)
- [Director's Order 87A, Park Roads and Parkways](#)
- [Park Road Standards \(1984\)](#) (PDF format, 11MB)
- [Park Roads and Parkways](#) (NPS Intranet Site)
- [Director's Order 87B, Alternative Transportation Systems](#)
- [Alternative Transportation Systems Guidebook](#)
- [Alternative Transportation Web Site](#)

- [Director's Order 87D, Non-NPS Roads](#)
- [The Secretary of the Interior's Standards for the Treatment of Historic Properties, 1995](#)
- [Director's Order 28, Cultural Resource Management](#)
- [Director's Order 17, Tourism](#)
- [Manual on Uniform Traffic Control Devices \(MUTCD\)](#), 1988 Edition U.S. Department of Transportation - Federal Highway Administration
- [Transportation Equity Act for the 21st Century \(TEA-21\)](#)
- [Federal Lands Highway, Project Development and Design Manual](#), U.S. Department of Transportation - Federal Highway Administration
- Federal Lands Highway Construction Manual, U.S. Department of Transportation - Federal Highway Administration
- Flexibility in Highway Design, U.S. Department of Transportation Officials - Federal Highway Administration
- [Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects](#), U.S. Department Of Transportation - Federal Highway Administration
- Part 2, Designing Sidewalks and Trails for Access, U.S. Department of Transportation - Federal Highway Administration
- Guide for the Development of Bicycle Facilities, American Association of State Highway and Transportation Officials
- Transportation Planning Guidebook, U.S. Department of Interior - National Park Service
- [National Scenic Byways Guide](#), May 2002
- [Inventory and Assessment of NPS Visitor Transportation Systems - Final Report](#) - August 1999
- [Federal Acquisition Regulations System](#)
- [UniGuide - Identification Wayfinding and Visitor Information for National Parks](#) (.pdf file), U.S. Department of Interior - National Park Service
- [1988 National Park Service Sign Manual](#) (See Director's Order 52C)

### **Cultural Landscape Report**

- [NPS-28 Cultural Resource Management Guideline](#), Chapter 7: MANAGEMENT OF CULTURAL LANDSCAPES
- Cultural Resource Management Guidelines, *The Secretary of the Interior's Standards for the Treatment of Historic Properties, with Guidelines for the Treatment of Cultural Landscapes and the Guide to Cultural Landscape Reports: Contents, Process, and Techniques*.
- A Guide to Cultural Landscape Reports: Contents, Process and Techniques by Robert R. Page, Cathy A. Gilbert, and Susan A. Dolan. U.S. Department of the Interior, National Park Service, Cultural Resource Stewardship and Partnerships, Park Historic Structures and Cultural Landscape Program, Washington, DC, 1998
- A cultural landscape report (CLR) is the primary guide to treatment and use of a cultural landscape. Based on the historic context provided in an historic resource study, a CLR documents the characteristics, features, materials, and qualities that make a landscape eligible for the National Register. It analyzes the landscape's development and evolution, modifications, materials, construction techniques, geographical context, and use in all periods, including those deemed not significant. Based on the analysis, it evaluates the significance of individual landscape characteristics and features in the context of the landscape as a whole. Typically

interdisciplinary in character, it includes documentation, analysis, and evaluation of historical, architectural, archeological, ethnographic, horticultural, landscape architectural, engineering, and ecological data as appropriate. It makes recommendations for treatment consistent with the landscape's significance, condition, and planned use.

- A CLR's scope and level of investigation will vary depending on management objectives. It may focus on an entire landscape or on individual features within it.

## **Cultural Landscape Inventories**

### **NPS Cultural Inventory Professional Procedures Guide (2001) and NPS DO-28:**

- The Cultural Landscapes Inventory (CLI) is a computerized, evaluated inventory of all cultural landscapes in which the NPS has or plans to acquire any legal interest. Its purpose is to identify cultural landscapes in the national park system and provide information on their location, historical development, character-defining features, and management. The CLI assists park managers in planning, programming, and recording treatment and management decisions. CLI forms, including maps, drawings, and photographs, are maintained in the support offices and parks.
- For more information on documentation, evaluation, and registration, see National Register Bulletins:
  - [How to Evaluate and Nominate Designed Historic Landscapes \(#18\)](#)
  - [Guidelines for Evaluating and Documenting Rural Historic Landscapes \(#30\)](#)
  - [Guidelines for Evaluating and Documenting Traditional Cultural Properties \(#38\)](#)
  - [Guidelines for Identifying, Evaluating, and Registering America's Historic Battlefields \(#40\)](#)
  - [Guidelines for Evaluating and Registering Cemeteries and Burial Places \(#41\)](#)
  - [Guidelines for Identifying, Evaluating and Registering Historic Mining Properties \(#42\)](#)
  - In addition, see the [NPS Cultural Landscapes Inventory Professional Procedures Guide](#).

## **Architectural Design Standards**

### **Fire Safety Plan**

**RM 58 (Draft) requires that all projects develop a Fire Safety Plan to address the unique fire and life safety issues. This complex of buildings needs such a plan. The Fire Safety Plan consists of the following elements.**

#### **INTRODUCTION**

#### **DESIGN TEAM**

#### **APPLICABLE CODES**

#### **FIRE PROTECTION/LIFE SAFETY APPROACH**

- General Description
- General Fire Resistive Construction Aspects
- Occupancy Classifications
- Fire Resistive Separations
- Doors and Windows
- Interior Wall, Ceiling and Floor Finishes
- Decorative Structures within Buildings



Egress  
Special Design  
Emergency Signage  
Suppression Systems  
Fire Department Access  
Fire Detection and Alarm System  
Emergency Communication Systems  
Smoke Management Description  
Central Control Station  
Emergency and Standby Power  
Elevators  
ACCEPTANCE TESTING  
PERIODIC OPERATION AND MAINTENANCE  
CONCLUSION

### Codes and Regulations

- **International Building Code (IBC), 2003**
- **Uniform Federal Accessibility Standards (UFAS), 1984**
- Americans with Disabilities Act (ADA) (See US Access Board for reference materials for ADA compliance)
- **Director's Order (DO) 50B, Occupational Safety and Health Program, Section 12, "Fire Safety"**
- **Director's Order (DO) 58, Structural Fire Management**
- **The Secretary of the Interior's Standards for the Treatment of Historic Properties, 1995**
- **Director's Order (DO) 28, Cultural Resource Management**
- **Director's Order (DO) 89, Acquisition and Management of Leased Space**
- **41 CFR 101-17 Assignment and Utilization of Space**

### Architectural Drawing Preparation Requirements

See [Deliverables](#) (Create Link)

[NPS/DSC CAD Architectural Model/Paper Space Standard](#)

### Historic Structure Report

- [Historic Structure Report Template](#) (Excerpt from Cultural Resource Management Guideline, Release No. 5 1997)
- Director's Order (DO) 28, June 11, 2002

## Structural Design Standards

### Codes

- IBC 2003
- ASCE 7-98
- ACI 318-99
- ACI 301-99
- ACI 530/530.1-02
- AISC ASD 9th edition or LRFD 3rd edition
- AISC Code of Standard Practice for Steel Buildings and Bridges, March 7, 2000
- NDS-97
- AITC Manual 4th edition

### Load Requirements

- Floor live Load: IBC 2000

- Roof Live Load: IBC 2000
- Snow Load: as required for building location
- Wind Load: as required for building location
- Seismic: as required for building location
- Vehicle Bridges: HS20
- Pedestrian Bridges and Boardwalks: 85 psf

### **Foundations**

- Frost Depth: As required for building location

### **Concrete**

- Minimum slab-on-grade thickness, 5"
- Minimum compressive strength at 28 days: 4000 psi
- Reinforcing steel: ASTM A615 Grade 6

### **Masonry**

- Concrete masonry minimum f'm: 1500 psi
- Reinforcing Steel: ASTM A615 Grade 60
- Below grade walls and retaining walls grouted solid

### **Steel**

- W Shapes: ASTM A992, 50 ksi
- S, M, HP and Channels: ASTM A36 or A572 Grade 50
- Angles and Plates: ASTM A36
- TS or HSS: ASTM A500, Grade B, 46 ksi
- Minimum Fillet Weld Size: 3/16"

### **Wood**

- Minimum roof sheathing thickness, 5/8"
- Minimum wall sheathing thickness 1/2"
- Framing Lumber (depending on location and availability)
  - Southern Pine No. 2
  - Hem Fir No.2
  - Douglas Fir Larch No.2 or better
- Provide blocking between roof framing members at bearing locations
- Provide plywood or OSB sheathing over heavy timber decking to create a diaphragm

## **Mechanical Design Standards**

### **Codes and Standards**

#### **HVAC**

- ANSI/ASHRAE 15-1994, "Safety Code for Mechanical Refrigeration"
- ASHRAE 62-1999, "Ventilation for Acceptable Indoor Air Quality"
- ASHRAE 90.1-1999, "Energy Standard for Buildings Except Low-Rise Residential Buildings"
- ASHRAE 90.2-1993, "Energy-Efficient Design of New Low-Rise Residential Buildings"
- UMC 2003 Uniform Mechanical Code"
- NFPA Codes and Standards
- 1995 SMACNA HVAC Duct Construction Standards

#### **Plumbing**

- UPC Uniform Plumbing Code"
- USATB Americans with Disabilities Act Accessibility Guidelines (ADAAG - Barrier-Free Plumbing Fixtures)

**Fire Protection**

- UFC 2000, "Uniform DO 58 Structural Fire Code"
- NFPA Codes and Standards

**Fuel Systems**

- NFPA Codes and Standards
- API RP 1615-1996, "Installation of Underground Petroleum Storage Systems"

**Stationary Engines and Cogeneration**

- NFPA Codes and Standards

**Conveying Systems**

- ANSI A17.1-1996, "Safety Code for Elevators and Escalators"
- ANSI A17.2-1988, "Inspectors' Manual for Elevators and Escalators"
- ANSI B30.11-1998, "Monorails and Underhung Cranes"
- ANSI B30.16-1998, "Overhead Hoists (Underhung)"
- ANSI A117.1-1986, "Making Buildings and Facilities Accessible and Usable by Physically Handicapped People"
- ANSI/ALI ALCTV-1998, "Safety Requirements for Automotive Lifts - Construction, Testing, and Validation"
- ANSI/ALI ALIS-2001, "Safety Requirements for Installation and Service of Lifts"
- ANSI/MMA MH27.1-1981, "Specifications for Underhung Crane and Monorail Systems"
- CMAA 70-1994, "Specification for Electric Overhead Traveling Cranes"
- CMAA 74-1994, "Specification for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes"
- HMI 100-1974, "Specification for Electric Wire Rope Hoists"

**Mechanical Drawing Preparation Standards**

- [See General Design Standards](#)
- [NPS/DSC CAD Model/Paper Space Standard](#)

**Mechanical Design Requirements and Guidelines**

- HVAC
  - Outdoor Design Conditions: 2001 ASHRAE "Handbook of Fundamentals", Chapter 27 (Climatic Design Information)
  - Building Material Thermal Properties: 2001 ASHRAE "Handbook of Fundamentals", Chapter 25 (Thermal and Water Vapor Transmission Data)
  - Indoor Design Conditions for Public, Office, and Living Spaces:
    - Winter: 72 degrees F
    - Summer: 75 degrees F
    - Maximum Relative Humidity: 60%
  - Indoor Design Conditions for Shop and Storage Spaces:
    - Winter: 65 degrees F
    - Summer: 80 degrees F
  - General Ventilation: In accordance with ASHRAE 62.
  - Restroom Ventilation: Minimum 2 CFM per square foot of floor area.
  - Acoustical Criteria (maximum values):
    - Auditoriums and Exhibit Spaces: NC25
    - Office Spaces: NC35
    - Shop Spaces: NC45
- Refrigerant Bearing Equipment: All refrigerant bearing equipment shall be CFC-free.

- Plumbing
  - Domestic Water Heating: 1999 ASHRAE "Handbook of Applications", Chapter 48 (Service Water Heating)
  - Compressed Air Systems: 1988 CAGI "Compressed Air and Gas Handbook"
  - Plumbing Fixtures: All plumbing fixtures and fittings shall be low-flow water conserving types, conforming to 1992 Energy Policy Act requirements.
  - Backflow Prevention: Comply with each park's backflow prevention regulations. As minimums, provide double check valve assemblies on all fire services or other water service connections that may produce objectionable backflow and reduced pressure zone backflow assemblies on all makeup water connections to HVAC equipment or other water service connections that may produce hazardous backflow.
  - Metering: All domestic water, reclaimed water, and fuel gas services to each building shall be metered in accordance with NPS Staff Directive 78-10.
  - Water Pressure: Pressure reducing valves shall be provided as necessary to limit water pressure in buildings to 80 psig maximum. Booster pumps shall be provided as necessary to maintain a minimum of 25 psig at the furthest plumbing fixture at design flow rate conditions.

## Fire Protection

- New buildings, buildings undergoing renovation, or buildings with a change in occupancy, shall be provided with automatic sprinkler system protection per NPS Director's Order 50B, Occupational Safety and Health Program.
- Occupancy Hazards: Occupancy hazards for fire sprinkler system design shall be in accordance with NFPA 13.
- Residential Sprinkler Systems: Residential occupancies shall be provided with fire sprinkler systems conforming to NFPA 13D or NFPA 13R.
- Valve Supervision: Main control valves shall be electrically supervised open.
- Piping: Piping for fire sprinkler systems other than residential shall be Schedule 40 steel pipe. Schedule 10, thinwall, or threadable thinwall piping will not be acceptable. Pipe and fittings for dry pipe systems shall be hot-dip galvanized.
- Dry pipe or anti-freeze systems shall be provided where there is the possibility of freezing.
- Fire pumps or pressure tanks shall be provided as necessary when the available site water pressure is insufficient to meet the calculated sprinkler system hydraulic demand.

## Electrical Design Standards

### Codes:

- NFPA Codes and Standards
- NESC National Electrical Safety Code
- IEEE- Standards
- IESNA 9th Edition - Illuminating Engineers Society of North America
- EIA/TIA Standards 568 & 569

### Load Requirements:

- NEC 2002
- Nameplate/Manufacturers Data
- 25-30% typical for future expansion

### Utilities:

- Underground distribution as much as possible
- NPS prefers not to own & operate utilities

### Telecommunication:

- EIA/TIA Standards, see above
- Cat 5 Cabling - (2) per 3/4" conduit; (1) Data, (1) Voice

- Telephone - Meet Local Phone Company Requirements

**Conduit:**

- Site specific, in general Schedule 40 PVC for underground
- Minimum branch circuit conduit size = 3/4"
- Provide conduit for telephone and data wiring (minimum size 3/4")
- See table below

**Power Wiring:**

- THWN / THHN
- Underground - THWN / XHHW
- Copper conductors

**Overcurrent Protection:**

- Breakers preferred for reset capability (sizes 15 amperes or greater)
- Fuses comply with NEC

**Equipment and Materials:**

- UL listed for application
- Conduit - see table below for environment and use

ENVIRONMENT	RACEWAY	BOXES, ENCLOSURES, CABINETS
Dry locations, concealed	RMC, IMC, EMT, RNC, ENT <sup>1</sup> , FMC, LFMC, LFNC, WW	SM, FS/FD, NM, NEMA 1
Exposed, subject to damage	RMC, IMC	SM, FS/FD, NM, NEMA 1
Exposed, not subject to damage	RMC, IMC, EMT, RNC, ENT <sup>2</sup> , FMC, LFMC, LFNC	SM, FS/FD, NM, NEMA 1
Wet locations, subject to damage	RMC <sup>3</sup> , IMC <sup>3</sup> , EMT <sup>3</sup> , WW <sup>7</sup>	FS/FD, NEMA 4, 4X
Wet locations, not subject to damage	RMC <sup>3</sup> , IMC <sup>3</sup> , EMT <sup>3</sup> , RNC, ENT <sup>2</sup> , LFMC, LFNC, WW <sup>7</sup>	FS/FD, NM, NEMA 4, 4X
Outdoor locations, exposed to rain, sleet, wind-blown dust, and external icing	RMC <sup>3</sup> , IMC <sup>3</sup> , EMT <sup>3</sup> , LFNC, WW <sup>7</sup>	FS/FD, NEMA 3, 3R, 3S
Submerged	RMC <sup>3</sup> , IMC <sup>3</sup> , RNC	NEMA 6, 6P
Embedded in concrete	RMC, IMC, EMT <sup>4</sup> , RNC, ENT <sup>4</sup>	FS/FD
Under concrete slab	RMC, IMC, EMT <sup>4</sup>	
Underground, direct burial	RMC <sup>3</sup> , IMC <sup>3</sup> , EMT <sup>3</sup> , RNC, ENT, LFNC	

Embedded burial	RMC, IMC, EMT <sup>4</sup> , RNC, ENT <sup>4</sup> , LFNC	
Industrial location, general	RMC, IMC, EMT, RNC, FMC, LFMC, WW	FS/FD, SM, NEMA 12, 12K
Subject to corrosion	RMC <sup>3</sup> , IMC <sup>3</sup> , EMT <sup>3</sup> , RNC, LFMC	NEMA 4X, 11
Subject to oil, vapors	RMC, IMC, LFMC	FS/FD, NEMA 13
Hazardous Class I, Division 1 <sup>8</sup>	RMC, IMC, FMC <sup>8</sup>	NEMA 7, 8
Hazardous Class I, Division 2 <sup>8</sup>	RMC, IMC, LFMC, FMC, WW <sup>5</sup>	FS/FD, NEMA 1, 7, 8, 12
Hazardous Class II, Division 1 <sup>8</sup>	RMC, IMC, LFMC, WW <sup>5</sup>	NEMA 9
Hazardous Class II, Division 2 <sup>8</sup>	RMC, IMC, LFMC, WW <sup>5</sup>	FS/FD, NEMA 1, 9, 12
Hazardous Class III <sup>8</sup>	RMC, IMC, LFMC, WW <sup>5</sup>	FS/FD, NEMA 12

TABLE LEGEND	TABLE NOTES
RMC - Rigid metal conduit IMC - Intermediate metal conduit EMT - Electrical metallic tubing FMC - Flexible metal conduit LFMC - Liquidtight flexible metal conduit RNC - Rigid nonmetallic conduit ENT - Electrical nonmetallic tubing LFNC - Liquidtight flexible metal conduit WW - Wireway SM - Sheet metal box FS/FD- Cast metal box NM - Nonmetallic NEMA - Re: NEMA 250 type classification	1 — Finishes must provide barrier with 15-minute rating. 2 — Building not more than 3 stories above grade. 3 — Corrosion protection required. 4 — With fittings for purpose. 5 — Enclosed and gasketed. 6 — Dusttight wireway only. 7 — Raintight wireway only. 8 — Suitable for hazardous location.

## Roofing/Waterproofing Standards

### Codes

- IBC 2000
- IPC 2000
- National Roofing Contractors Association – Roofing and Waterproofing Manual
- ASCE 7
- Factory Mutual Global
- Underwriters Laboratory

### Design Requirements

- Wind load as calculated using ASCE 7
- Determination of fire rated roof Classification
- Roof drainage as calculated using IPC or other established sources
- Determine dew point location in roof assembly and vapor barrier needs

### Single-Ply Membrane Roofs

- Specify roofing products, all manufactured in the United States, supplied by a single manufacturer which has been successfully producing the specified types of primary products with the same materials without making adjustments, modifications or alterations to the chemical or physical composition of the products for not less than the warranty period.
- Specify a 20 year system and require a 15-year System Roofing Manufacturer's Warranty for labor and material, without monetary limitation, to correct defects in materials or workmanship. Warranty shall contain no exclusions for random occurrences of ponding water.
- Specify PVC (60 mil minimum thickness) and EIP (45 mil minimum thickness) systems to be mechanically attached or fully adhered when roof membrane is visible from ground.
- EPDM systems shall be fully adhered 60 mil thickness, using 7" wide tape seams, and be warranted for 20 years.
- Specify single-ply roof system when foot traffic is minimal, roof shape is complex or when numerous roof penetrations are present.
- Specify a dense, fire and water resistance cover board made from gypsum or other man made materials to be placed over the deck or insulation board
- Specify a pre-manufactured 2-piece counterflashing; coping system; and roof edge/fascia system
- Minimum roof pitch of ¼"/ft and 1/8"/ft along valleys

### SBS Modified Bitumen Roofs

- Specify 2-ply system where roofing products, including each type of sheet, are all manufactured in the United States, supplied by a single manufacturer which has been successfully producing the specified types of primary products with the same materials without making adjustments, modifications or alterations to the chemical or physical composition of the products for not less than the specified warranty period.
- Specify a 20 year system and require a 15-year System Roofing Manufacturer's Warranty for labor and material, without monetary limitation, to correct defects in materials or workmanship. Warranty shall contain no exclusions for random occurrences of ponding water.
- APA systems are not permitted
- Specify SBS roof systems where high puncture resistance, exposure to abuse or frequent access is needed on the roof to maintain mechanical equipment.
- Specify torch down and adhesive systems, avoid hot mop asphalt.
- Specify a dense, fire and water resistance cover board made from gypsum or other man made materials to be placed over the deck or insulation board
- Specify a pre-manufactured 2-piece counterflashing; coping system; and roof edge/fascia system

- Minimum roof pitch of ¼"/ft and 1/8"/ft along valleys

### **Asphalt Shingles Roofs**

- Specify a 2-ply laminated shingle, conforming to ASTM D3462, with a minimum 30-year material warranty and a minimum 5-year non-prorated labor and material watertightness warranty
- In humid and wet climates, specify algae resistant shingles
- In hailstorm areas, specify impact resistance shingles passing an UL 2218 test for Class 3 or 4.
- In high wind areas, (greater than 90 mph) specify wind resistant shingles rating to wind speed determined by ASCE 7, and require a 10-year wind warranty
- In snow/ice climates, specify fully adhered moisture protection underlayment extending from the eave to 3 feet from the inside face of the exterior wall, at valleys, ridges and along dormer or other walls. Use cold roof design technology if possible.
- Fasten shingles with minimum 12 gauge corrosion resistant nails only. Minimum nail head diameter shall be 3/8". Shank shall penetrate minimum of ¾" in wood decking or completely through plywood decking.
- Asphalt-saturated felt underlayment shall meet ASTM D 226 and/or D 4869. Use double layers on roof slopes less than 4:12.
- Specify roof perimeter edge metal and step flashing at walls and chimneys.
- Recommend the use of attic ventilation or other means of ventilating the area under the shingles
- Minimum slope 3:12.

### **Metal Roofs**

- Specify metal roof manufacturers who offer Full System Manufacturer's Roofing Warranty for 20-year labor and material warranty, for the installed cost of roof, to repair leaks in the roof panels, flashing and trim resulting from defects in materials or workmanship. Roof manufacturers shall be required to inspect the work during construction.
- Verify with manufacturer their underlayment requirement for the 20-year warranty
- Steep roof (hydrokinetic) roofs shall pass air and water infiltration tests per ASTM E1646 and E1680. Low slope (hydrostatic) roofs shall pass water infiltration tests per ASTM E2140. Submit test report.
- Specify Kynar 500 or Hylar 5000 paint finish on metal panels which require paint.
- Specify 22 gage galvalume/zincalume and/or galvanized metal roofs. For structures located in coast regions use 0.040" aluminum or 20 oz copper. For high profile structures, use any of the above 3 materials.
- For architectural panel roofs, specify snap type standing or batten seam with continuous length panels. Panel should be kept off substrate by manufacturer's clips. Double lock standing seams should only be used in high snow areas where snow will accumulate on the roof over the winter
- For structural or structural/architectural panel roofs, specify concealed fasteners and clips for panel attachment. No fasteners shall be located in the pan of the panel except at the ridge.
- Panels shall be rolled formed at the manufacturer's prime manufacturing plant
- Specify manufactured prepared shop drawing on a minimum 24" by 36" sheet.
- Metal shingles and shingle panels to be used on steep slope (3:12 or greater). Investigate the bottom, top and side of each shingle to determine the interlocking mechanism and watertightness of the lap, joint and seam. Examine ridge, valley, hip and perimeter flashings profiles for watertightness. These products maybe problematic on roofs that retain snow for long periods of time.
- Specify rosin paper slip sheet under all architectural metal roofs
- In snow/ice climates or as required for warranty, specify fully adhered moisture protection underlayment extending from the eave to 3 feet from the inside face of the exterior wall, at valleys, ridges and along dormer or other walls. Use cold roof design technology when possible.

### **Clay and Concrete Tile Roofs**

- Specify clay tile manufacturers who offer a 20-year labor and material warranty, for the installed cost of roof, to replace defective tiles resulting from defects in materials or workmanship



- Clay Tile shall meet or exceed ASTM C1167 Grade 1 requirements for durability and ASTM C1167 Type I for appearance
- Concrete tile shall meet or exceed ASTM C1492 requirements.
- In freeze/thaw climates specify clay tile manufacturers that have a moisture absorption rate of less than 1% per ASTM C67. Concrete tile shall have a minimum compressive strength of 7500 psi, shall not have more than 1% loss in dry weight per ASTM C67 and not absorb more than 8% of the dry weight in ASTM C140 immersion test.
- Specify 2 layers of 30# asphalt-saturated felt underlayment meeting ASTM D 226 and/or D 4869.
- In snow/ice climates or as required for warranty, specify fully adhered moisture protection underlayment extending from the eave to 3 feet from the inside face of the exterior wall, at valleys, ridges and along dormer or other walls. Use cold roof design technology if possible.
- In hailstorm areas, specify manufacturers who provide a minimum 10-year hail warranty covering material replacement of damaged tiles

### **Slate Roofs**

- Specify slate tile manufacturers provide a 75-year material warranty. The installer shall provide a 5-year leak proof warranty for the installed cost of the roof, to replace defective flashings and tiles resulting from defects in materials or workmanship.
- Specify slate manufacturers whose products meet ASTM C406 and can certify their slate to a Grade S1 classification by provide test results which are not more than 3 years old.
- Specify 3/8" minimum thick slate in freeze/thaw, high wind or heavy hail areas, 1/4" minimum thick slate in other areas. Avoid slate from Pennsylvania.
- Specify two layers of 30# asphalt-saturated felt underlayment meeting ASTM D 226 and/or D 4869 or one layer of fully adhered moisture protection 40 mil minimum butyl-adhesive based underlayment. Use a 3" minimum headlap for roof slopes between 4:12 to 8:12.
- In snow/ice climates, specify fully adhered moisture protection 40 mil minimum butyl-adhesive based underlayment extending from the eave to 3 feet from the inside face of the exterior wall, at valleys, ridges and along dormer or other walls. Use cold roof design technology if possible.
- Specify 10 gage copper slating nails, stainless steel, bronze or cut-brace roof nails and fasten with 2 nails per slate. In high wind areas or when 3/4" or thicker slate is used, fasten with 4 nails per slate.
- Provide eave cant for starter course.
- Flashings shall be fabricated from 20 oz copper or 24 gage stainless steel. Open valley pan shall be formed with a "W" or "V" shaped splash diverter.

### **Wood Shakes and Shingle Roofs**

- National Parks are slowly transitioning away from wood products as a result of increased fire danger throughout the west, the limited availability of domestic supplied material, and the reduce life expectancy of the product in many parts of the country. However, in some cases historic preservation standards may dictate the use of these products.
- Specify No. 1 premium official blue label western red cedar shingle; premium grade western red cedar shake; or pressure treated No. 1 vertical grain, all clear yellow pine shingle.
- Specify one layer (for shingles) or two layers (for shakes) of 15# asphalt-saturated felt underlayment meeting ASTM D 226 and/or D 4869 or one layer of fully adhered ice and water protection 40 mil minimum butyl-adhesive based underlayment. The second layer of felt is interlaced between courses when installing shakes.
- In snow/ice climates, specify fully adhered moisture protection 40 mil minimum butyl-adhesive based underlayment extending from the eave to 3 feet from the inside face of the exterior wall, at valleys, ridges and along dormers or other walls. Use cold roof design technology if possible.
- Use a 3 layer starter course for roofs with each course hanging over the lower one by 1/4".
- Specify a minimum 4:12 pitch roof, prefer a 5:12 minimum pitch and shingle widths between 3 and 9 inches.
- Specify copper or zinc sheets at ridge in humid climates to reduce moss growth
- Hand nail shakes and shingles. Nail guns and staples are not allowed

**Specialty Roofs**

- To be completed

**Waterproofing Systems**

- Specify waterproofing products, all manufactured in the United States, supplied by a single manufacturer which has been successfully producing the specified types of primary products with the same materials without making adjustments, modifications or alterations to the chemical or physical composition of the products for not less than the warranty period.
- Specify a minimum 10-year Manufacturer's Warranty for labor and material, without monetary limitation, to correct defects in materials or workmanship. Warranty shall contain no exclusions for random occurrences of ponding water.
- Specify the use of certified contractors to apply the waterproofing system and that the work be inspected by the manufacturer at a minimum of once a week during installation
- Waterproofing below the water table may limit the selection of the waterproofing membrane.
- The type of substrate the waterproofing will be applied to shall be considered before selecting the waterproofing system.